General Application Name: Public Works/Service Authority

Product / Service / Function Name: Wetlands Inventory

P/S/F Description:

Wetlands are a fragile part of the ecosystem and occupy a significant position in the maintenance of balanced environment. Wetland maps are a prerequisite for wetland inventory and for wetland development planning, management, protection, and restoration. Wetland inventory maps provide information on wetland type, location, and size. Detailed wetland maps are necessary for analysis of the effect of projects at specific sites and for providing baseline spatial data for the assessment of the effects of national policies and activities. Wetland maps are used by local, State, and Federal agencies, as well as by private industry and organizations. They are used for many purposes, including the development of comprehensive resource management plans, environmental impact assessments, natural resource inventories, habitat surveys, and the analysis of trends in wetland status.

Product / Service / Function

1. Spatial Data

Minimum Data Requirements

General Description	Data Layer
Physical Landscape	Wetlands
	Landscape classification (Estuarine, marine, etc)
	Geology
	Soils
	Vegetation
	Wildlife Habitat
	Streams
	Lakes
	Dams/Hydroelectric plants
	Flood zones
	Watershed delineations
Socio-Political Data	Land use
	Zoning
	Municipal Boundaries
	Demographic data
	Buildings
Other	Orthophotography
	Topographic maps

Optional Data Enhancements

General Description	Data Layer
Planimetric Data	Street Centerlines

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	Utilities
Physical Landscape	Historical maps (wetlands, land use, etc.)
	Contaminant sources
Socio-Political Data	Mines
	Historic Land Use
Other	Satellite imagery

2. Attribute Data

Minimum Attribute Requirements

General Description	Field Name
Wetlands	Classification
	Name or ID number
	Area
	Legal Access (Public/Private)
	Physical Access (Low/Med/High)
	Date of delineation
	Land Owner
Vegetation	Species
	Endangered classification
Wildlife Habitat	Species
	Endangered classification
Soils	Classification
Streams/lakes	Outlet Characteristics
	Channel Characteristics
	Groundwater interaction

Optional Attribute Requirements

General Description	Field Name
Wetlands	Method of delineation (survey, air photo)
Streams/Lakes	Overall water quality
	Pollutants
	Water usage
	Access rating
Land Use	Adjacent Land Use
	Historic Adjacent Land Use

3. Data Acquisition Options (integrated with VBMP digital orthos)

The US Fish & Wildlife Service is in the midst of completing the National Wetlands Inventory (NWI) for the entire United States. The wetlands are identified through air photo interpretation techniques. The goal of the NWI is to provide a better identification of the location of wetlands in the US than on USGS topographic maps. Data can be downloaded at

<wetlands.fws.gov/index.html>. However, the NWI data is not meant to be survey quality showing the exact boundaries of wetlands. Therefore, if a municipality requires a more precise inventory of wetlands in its jurisdiction, then either additional air photo interpretation with higher-precision orthophotos must be done or a field survey of the wetland should be conducted. Either of these tasks could be performed in-house or by a consultant.

Planimetric data such as utilities, building footprints, land use, streets, etc. are typically maintained at the county or city level. Additional spatial data layers can be obtained through the Internet from various government sources. Municipal boundaries and similar layers can be obtained in digital format through the U.S. Census Bureau <www.census.gov>. Floodplains can be obtained through the FEMA Web site <www.fema.com> and soils from the USDA at < http://www.statlab.iastate.edu/soils/nssc>.

Regardless of the source of the data, each data layer used to build the wetlands inventory application should be consistent with, or be modified to match, the projection of the Virginia Base Mapping Project (VBMP) orthophotography. This is vital for data consistency and facilitates data sharing across jurisdictional boundaries. The orthophotography is crucial to a wetlands inventory project not only for identifying the wetlands but also for displaying the information on maps.

3. Data Conflation Options (integrated with VBMP digital orthos)

Data conflation is a process by which two digital data layers, usually of the same area at different points in time, or two different data layers of the same area, are geographically "corrected" through geometrical and rotational transformations so that the different layers can be overlaid on one another. Also called "rubber-sheeting," this process allows a technician to adjust the coordinates of all features on a data layer to provide a more accurate match between known locations and a few data points within the base data set. A good base layer to use for data conflation is the VBMP orthophotos since many features can be seen or interpreted. The need and processes for conflation varies between sets of data, users, and feature types. Any dataset that is updated independently by different departments can be consolidated through conflation. Within most local governments, individual departments are responsible for maintaining specific datasets within their expertise; therefore, conflation is not often necessary. Often, reprojecting the data into a different coordinate system will take care of the misalignment of different data sets. Most industry-standard GIS software has the ability to perform data conflation.

In addition, NWI data or surveyed wetlands must be verified that they are in the VBMP projection and/or coordinate system with the rest of the base data (i.e. roads). The NWI data may not be in the desired time scale for the area of interest so high-resolution VBMP orthophotos would be ideal for updating the wetlands data layer.

4. GUI / Programming options

There are many options for developers of a wetlands inventory application. Two avenues within this development track are:

- Standard GIS desktop software that can be customized to the user's needs
- Hiring a consultant to develop a custom system from scratch.

Using a standard GIS software package often requires a significant amount of training and customization. Whereas the initial cost may be lower, the time invested in learning these solutions

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may generally increase the overall expense of implementation. However, standard GIS software packages deliver more robust data integration, analysis, and cartographic capabilities than do other specialized commercial applications. They have a greater user support infrastructure that allows users to overcome problems quickly. Options for using an existing, industry-standard GIS software application that can be customized for wetlands inventory include those listed in the following table:

Standard GIS Software Vendors:

Vendor	**Software**	**Web Address**
ESRI	ArcView 3.x	http://www.esri.com
ESRI	ArcGIS 8.x	http://www.esri.com
MapInfo	Professional 7.0	http://www.mapinfo.com
Intergraph	GeoMedia 5.0	http://www.intergraph.com/gis
Autodesk	Map 5.0	http://www.autodesk.com

Another option for developing and implementing a GIS-based wetlands inventory application is to contract with a consultant. This option makes certain that a product will fulfill a jurisdiction's requirements. A consultant will be able to develop an application that works with the wide range of hardware and software that are currently in use within local governments within Virginia. Also, training and follow-up user support is often provided at a much more substantial level than with other options.

There are potentially several uses for a customized wetlands inventory application:

- Generate wetlands inventory maps efficiently for public display or planning purposes.
- Analyze sources of pollution in relation to wetland locations.
- Aid in the preparation of environmental impact analysis projects.
- Assist biologists in the study of wildlife habitat.
- Corridor planning and analysis.
- Land use planning and rezoning issues.
- Master planning and capital improvement projects planning.

6. Internet Functionality and options

The Internet has proven itself as a viable solution for local governments to centralize the maintenance and management of services and data. As more local governments are implementing Web-based solutions, they are finding that the Internet requires them to change the nature of an application or its usefulness. Through the flexibility of an Internet solution, software can be easily updated, and users gain greater accessibility to the applications and information they need for their specific tasks through simple, user-friendly interfaces.

While desktop applications are mainly for staff and "power users," an application can be deployed on the Web to allow greater access to wetlands information for the community. For example, a municipality could display maps on the Web of proposed business parks and the wetlands that would have to be drained or show plans for a new city park that protects a local wetland area.

GIS software vendors have products that can be customized in-house or by a consultant to provide Web GIS applications on the Internet, over an intranet or via wireless network. The table

below shows GIS vendors and their Internet mapping solutions.

GIS Internet Solutions

Vendor	Internet Software	Web Address
ESRI	ArcIMS	http://www.esri.com/software/arcims
MapInfo	MapXtreme, MapX	http://www.mapinfo.com
Intergraph	GeoMedia WebMap	http://www.intergraph.com/gis/gmwm
Autodesk	MapGuide	http://www.autodesk.com

7. Technical Requirements

Minimum Technical Requirements

At its most basic level, a GIS-based wetlands inventory system can be used on a single, stand-alone workstation. This workstation would have a hard drive that stores all of the spatial data layers and other associated tabular data. A typical workstation running off-the-shelf software should have the following minimum specifications:

Processor:	Pentium 3, 450 MHz
RAM:	128MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19"
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional
Printer:	8x11 office-grade color printer

Optimum Technical Requirements

A more intensive wetlands inventory system may require multiple components, including servers and desktop workstations. Some examples specifications of the necessary equipment are listed below:

Server

Processor:	Min. 2x Processors, 1.7 GHz, 512K cache
RAM:	Min. 2x 512MB RIMMS
Hard Disk:	Min. 2x 80GB +RAID
Monitor 1:	19"
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
Network Card:	10/100 mbps

Workstation

Processor:	Pentium 4, 1.5 GHz
RAM:	512MB SDRAM at 133MHz

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Hard Disk:	20GB (min.)
Monitor 1:	19”
Monitor 2:	17”
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD-RW drive
Modem:	56K
Network Card:	10/100 mbps
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional

Other Components

Printer:	8x11 office-grade color printer and 8x11 production b/w printer
Plotter:	HP DesignJet 1055CM
Tape Backup:	Tape Library Server
UPS:	APC 1400 (or other similar)
Scanner:	11x17
Handheld:	Compaq IPAQ
Network:	T1

8. Administrative/Management Requirements

At the beginning of the project, the assigned project manager from the particular municipality should consider completing some, if not all of the following tasks that relate to the administrative requirements of wetlands inventory system:

- Determine, with or without the assistance of a consultant, the preliminary vision and goals of the project.
- Coordinate an initial meeting with the stakeholders (i.e. the Board of Supervisors, local/state environmental agencies, planning department, etc.) where the vision and goals of the project are expressed and the background of GIS technology is described, if needed.
- Coordinate with other municipal agencies for data sharing provisions.
- Determine a mechanism of communication to keep the decision-makers aware of the progress of the project.
- Develop a basic understanding of the available precedents in the region/state and research the available technologies that can be applied to the project.

Upon project completion, a basic wetlands inventory application will require very little administrative support. Administrative tasks may include loading or upgrading new versions of the software or patches, providing for constant data flow from the source database, and maintaining yearly support contracts on the hardware and software. However, once the system becomes distributed as an enterprise solution to many users throughout a department or deployed on the Internet, there are various other management requirements that need to be fulfilled on a weekly or monthly basis.

At the point where the system grows beyond single desktop users, a devoted administrator or system manager needs to be established. This is essential for the following reasons:

- The system will now be interfacing with other technology systems already in place. Therefore, someone will need to maintain contact with the technology personnel that

maintain these systems.

- The manager needs to put into place training schedules to maintain user knowledge of the system.
- Funding will undoubtedly be required to either maintain the system long-term, or continue to expand the system, which requires funding research and applications for grants.

9. Costs:

Hardware	**Typical Unit Cost**
Minimum Workstation	$2,000
Optimum Workstation	$3,200
Laptop	$2,400
Web/FTP Server	$8,500
Database Server	$12,000
Data Warehouse Server	$18,000
Backup Server	$5,800
Printer (8x11 color)	$700
Printer (8x11 b/w production)	$2,000
Plotter	$12,000
Tape Library	$5,000
UPS	$700
Scanner	$1,500
Handheld	$300-$700

Software (all prices included license)	**Typical Unit Cost**
Standard GIS desktop software	$700-$10,000
Customized desktop vendor solution	$5,000-$15,000
Web-based vendor application	$15,000-$25,000
Customized web-based vendor solution	$20,000-$60,000

Miscellaneous	**Typical Unit Cost**
Training - focused vendor training (per person)	$700-$1,000
Training - general GIS	$700-$1,200
Licensing – desktop	$100-$500
Licensing – webapp (1st CPU)	$7,500-$12,000
Maintenance (per year)	$8,000-$15,000

10. Standards / Guidelines Summary
    - Wetland inventory is a data intensive project. Periodic surveys on vegetation and wildlife changes should be planned.
    - Changes in the demographics and land use patterns also need to be monitored for their impact on wetlands.
    - When collecting information about wetlands, use the standards of the NWI classification <http://www.nwi.fws.gov/atx/atx.html>.
    - Use large-scale (1:100') orthophotos for identification of wetland boundaries.
    - For even greater accuracy, conduct field surveys of local wetlands.
    - Acquire input from all departments who will be involved in funding and/or utilizing the

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application before proceeding with the application design.

- Develop a detailed Quality Assurance/Quality Control (QA/QC) procedure for reviewing the accuracy of the GIS data and its attributes.
- Maintain data in the VBMP standard coordinate system (Virginia State Plane, NAD 83, Survey Feet).
- Create metadata (standard information about GIS data) for each data layer. Metadata tracks the date, origin, coordinate system, and other such information for data layers.

11. Startup Procedures/Steps

There should be a minimum of eight steps involved with developing a GIS-based wetland inventory application, after funding is in place to support the project. The steps can be performed in-house or by a consulting team.

The first task is to complete a detailed Needs Assessment. This process gathers information regarding existing operational procedures, hardware and software, GIS data, and personnel needs. It should include interviews of key individuals throughout the local government agency and other related government departments to obtain a comprehensive view of the agency's operations, and where GIS might improve them. Basic GIS concepts should be discussed and illustrated to those interviewees that have little prior understanding of GIS. A comprehensive Needs Assessment should then be compiled from the results of the interviews. This document explains the various requirements for a wetlands inventory application in the following areas: personnel needs, spatial data development needs, applicable spatial analysis techniques, basic system requirements, including preliminary, general hardware and software recommendations, and training needs.

The second task is to develop a functional requirements document for the proposed application. This document should describe, as completely as possible, all of the technology and functionality that is to be included in the system. This document is used by the local government agency, or its consultant, as the blueprint for the GIS application or system. It should include:

- Hardware specifications
- Software purchases
- Detailed descriptions of work-flow, and examples of the graphic user interfaces
- Describe each tool that is part of that graphic user interface, and its functionality
- Describe how data would flow between the different databases and data warehouses, if applicable
- Describe the redundant security measures that will be put in place to make certain of data integrity and confidentiality, when applicable
- Analytical techniques that the application/system provides the user for wetlands analysis
- Describe each of the potential products (reports, maps, charts, summary tables) that the user will be able to generate within the system

The third task should be to compile or develop spatial data that can be used by the property assessment application. Data can be gathered from a number of online sources, as well as county/city departments. The data layers gathered and maintained should match at least the minimum list provided in Section 1 of this document and can be acquired through the methods described in Section 3 of this document.

On completion and acceptance of the functional requirements document and the development of

the spatial and attribute data, the system development and test phase can begin. During this time, the application will be customized as it was outlined in the functional requirements phase. The local government agency should require periodic reviews of the application at particular milestones, such as 50% and 75% completion. This will make certain that problems with the application will be recognized early in the development process, and that the local government agency remains a part of the development process throughout the project timeline.

When the application is nearing 100% completion, it should be installed and tested in the environment in which it will ultimately be used. This allows the users to test the system alongside the application developers, and determine any system integration problems that might arise. It also gives the developers the opportunity to test the application's functionality in a real-world situation. This testing process should be as comprehensive as possible. Each process detailed within the functional requirements should be tested and evaluated at this point.

User training commences once the application reaches 100% completion and is fully documented. Different levels of tutorials and system documentation should be developed depending on the hierarchy of users. Time should be spent at this stage of the project with each potential user of the system to make certain that the proper education occurs. Training should be done through lessons that use real-life examples of system application. This strategy greatly enhances users' ability to apply the functionality to their jobs.

The next phase of the project should include a document that describes a future plan for wider system development. This document accomplishes two goals. The future plan gives the local government agency ideas on how the system might grow to assist other facets of its business practices. Secondly, it provides the agency with a ready-made grant proposal for applying for potential funding sources.

The final phase of a successful implementation of a GIS-based wetland inventory application is ongoing technical support. The local government agency should always include this contingency within its cost estimates of a project for a minimum of three months after a system has been put into place. No matter how effective an application appears, problems and system changes inevitably impact the functionality of an application.

22. Estimated time line and/or implementation (stand alone) schedule

Phase	**Duration**
RFP/Contract process (construction, posting, proposal acceptance, review, award of contract)	4 months - 1 year
Needs Assessment	1 month
Data Development	3-8 months
Customized Application Development	3-5 months
User Training	½ month
Plan for Future Development	¼ month
Ongoing Support	3 months

23. Best Practice Examples in Virginia

Virginia Institute of Marine Science
GIS Dept.
PO Box 1346
Gloucester Point, VA 23062
804-684-7088
http://www.vims.edu/

Chesapeake Bay Local Assistance Department (CBLAD)
101 N. 14th Street, 17th Floor
Richmond, VA 23219
804-225-3440
http://www.cblad.state.va.us/gis.htm